Physics

Lesson Plan #4
Vector Addition
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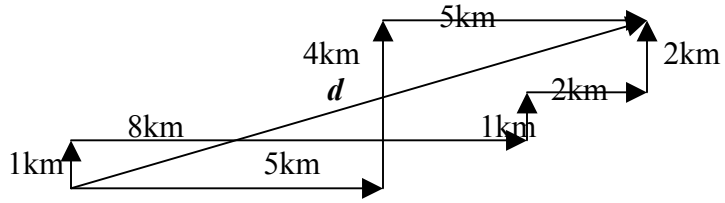
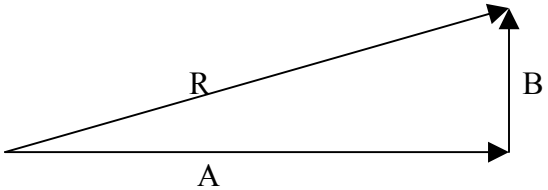
Properties of Vectors
Objectives: How to represent vector quantities graphically and algebraically; Determine the sum of vectors both graphically and algebraically

- Graphical Representation
  - Learned in previous chapter
  - Arrow with head indicate direction
  - Length to indicate magnitude
- Algebraic Representation
  - Displacement + direction in words
    - ***d*** = 50 km, southwest
- Resultant Vector
  - Sum of two or more vectors

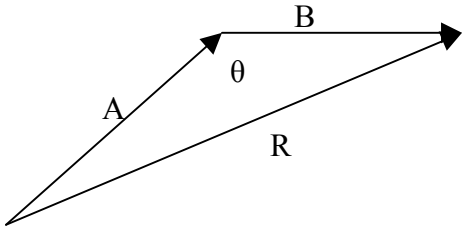


- Graphical Addition of Vectors
  - Using the above example and graph paper, ruler and protractor
  - Draw 5km E, 4km N and 5km E, draw Resultant
  - Draw 1km N, 8km E, 1km N, 2km E, 2km N, draw resultant
  - Magnitude of resultant is found by measuring the length of the resultant
  - Direction is found using protractor
    - Answer would be 10.77 km 24º north of east

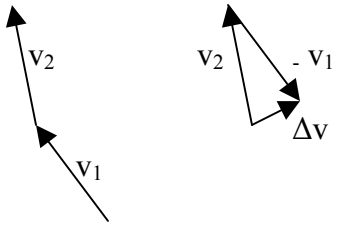
- Special cases
  - If right angles are involved then the Pythagorean theorem can be used – R2 = A2 + B2



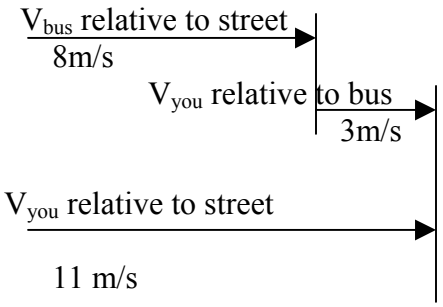
- Where there is no right angle the Law of Cosines can be used – $R^2 = A^2 + B^2 - 2AB\cos\theta$

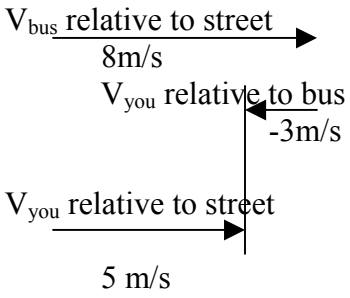


- Subtracting Vectors
  - Vectors can be multiplied by scalar numbers
    - Changes the magnitude not the direction
    - Unless you multiply by a negative number
    - You can use this to subtract 2 vectors

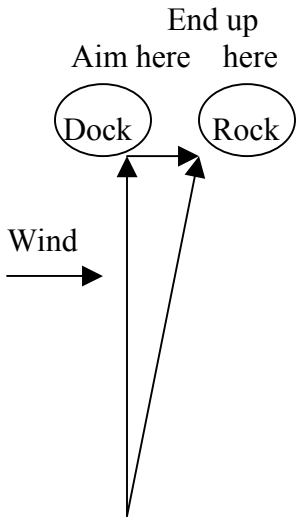


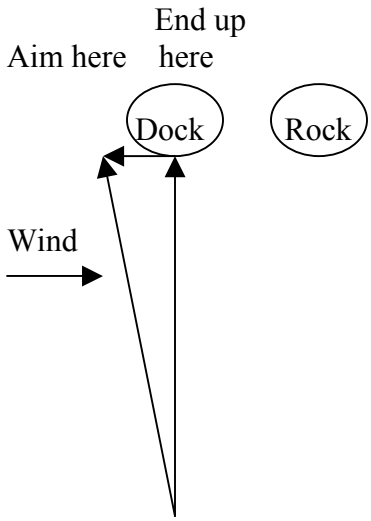
  - Relative Velocities
    - What motions are we under going sitting in the classroom?
      - Earth rotates around it's axis
      - Earth revolves around the sun
      - The solar system rotates around the center of the galaxy
      - The galaxy is in motion with a local group of galaxies
      - The universe is expanding
    - You can use graphical addition of vectors to solve relative motion problems
    - You are traveling on a school bus that is moving at 8 m/s. You walk toward the front at 3m/s (relative to the bus)
      - What is your speed relative to the street?





- Concept can be used in two dimensions
  - Take a sailboat – a side wind will move the boat forward, but also move the boat slightly sideways. To reach a particular destination, the skipper must steer a course that will counter act the sliding.





- You can add vectors at arbitrary angles using the graphical method

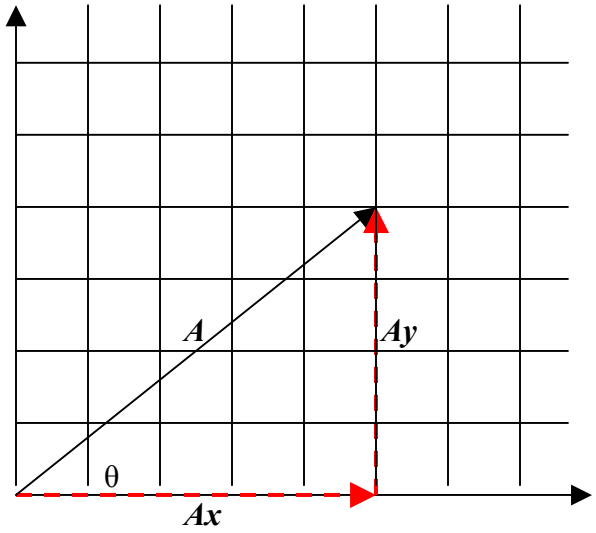
Components of Vectors

Objectives: Establish a coordinate system in problems involving vector quantities; Use the process of resolution of vectors to find the components of vectors; Determine algebraically the sum of 2 or more vectors by adding the components of the vectors.

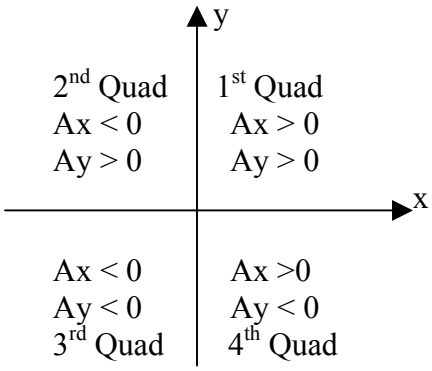
- Choosing a Coordinate System
  - Using an x-y coordinate system - there is no right way to set it up (as long as the axis are at right angles to each other)
  - By convention, x increases as it moves to the right from the origin, and y is 90º counterclockwise from the x axis and increases as y moves away from the origin
  - On maps, x points East and y points North

- On problems involving motion through the air, y is the vertical motion and x is the horizontal motion
- On problems on an incline, +x is set in the direction of motion and y perpendicular to the x axis

- Components
  - A vector can be broken up into x & y components



  - Here vector ***A*** is resolved into two component vectors, ***Ax*** which is parallel to the x axis and ***Ay*** which is parallel to the y axis
  - ***A*** = ***Ax*** + ***Ay***
  - Vector resolution is the process of breaking a vector into is components. (***Ax*** & ***Ay*** are call components)
  - Algebraic calculations use only the components of vectors – not the vectors themselves
  - Use trigonometry to find the components
    - $A_x = A\cos\theta \rightarrow \cos\theta = \frac{adjacent \cdot side}{hypotenuse} = \frac{A_x}{A}$
    - $A_y = A\sin\theta \rightarrow \sin\theta = \frac{opposite \cdot side}{hypotenuse} = \frac{A_y}{A}$
    - When the angle that a vector makes with the x axis is larger than 90º (vector is in 3rd or 4th quadrant) the sign of one or more components is negative.



- Algebraic Addition of Vectors
  - Two or more vectors may be added by first resolving each vector into it's x & y component
  - Add the x components together, add the y components together
  - For a right triangle, use the Pythagorean theorem
    - $R^2 = R_x^2 + R_y^2$
    - The angle or direction of the resultant can be found by $\tan\theta = \frac{R_y}{R_x}$